SP-E1.2 Local Operations Model Development

October 25, 2002

1.0 Introduction/Background

The Statewide Operations modeling defines the gross monthly average operation of Oroville Reservoir. Within the boundaries defined by the Statewide Operations modeling there is an opportunity to operate the Oroville/Thermalito complex to meet very short term, local operation goals, especially power generation. This local operation requires more detailed modeling of the operations of the Oroville/Thermalito complex on a much shorter, probably hourly, timestep than the statewide operation modeling. The statewide operations modeling will set monthly and/or weekly operation limits on total reservoir releases to ensure appropriate water supply operations. The local operations modeling will optimize the detailed operations within the water supply operation and other short-term operation constraints to maximize power generation.

2.0 Study Objective

The goal of this study is to develop appropriate local operation modeling tools and perform the benchmark simulations to allow detailed evaluations of the Oroville/Thermalito operational alternatives.

3.0 Relationship to Relicensing /Need for the Study

The relicensing process requires analysis of potential impacts from a wide range of operational alternatives. The model developed as a result of this study will be used to produce simulated operational data from these alternatives for use in the required analysis.

The purpose of this study is to produce a tool that can be used to provide the detailed local water and power operations of the Oroville /Thermalito Complex. These detailed operations are required for use in further modeling activity as well as directly in the impact analysis process. Without this tool the analysis based on the simulated operation data from the tool could not be performed.

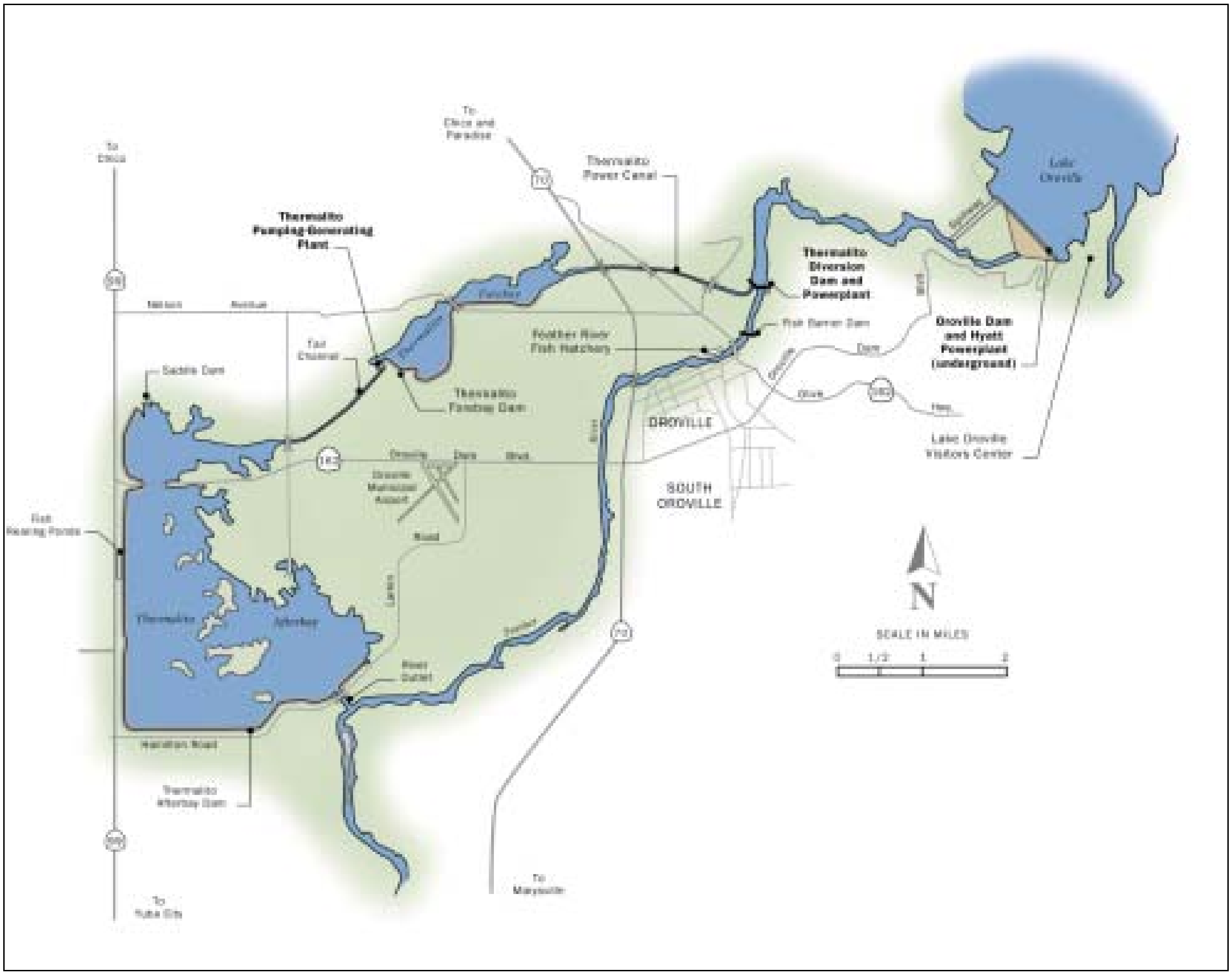
Engineering and Operations Issues Addressed

- E1—evaluate the potential for adding additional generation using existing infrastructure, modifying facilities to increase storage and associated generation, and changing operation to provide spinning reserve (e.g., motoring) (Issues addressed: EE 1, 2, and 14).
- E4—evaluate environmental and economic aspects of different flow regimes of Oroville Facilities operations. Factors to be considered include timing, magnitude and duration of flows, pump-back scheduling and maintenance scheduling, and hatchery operations.
- E6—effect of ramping rates on downstream facilities, power generation, water supply, water temperatures, and fish.

- E7—effect of the project including discharge (magnitude, frequency and timing) and ramping rates and the altered stream hydrology on substrate scour, mobilization of sediments, turbidity levels, and riparian vegetation in the low flow reach and downstream of the Afterbay.
- E10—effect of future water demands on project operations including power generation, lake levels and downstream flows. Consider sale of existing water allotments to downstream users.
- E12—evaluate operational and engineering alternatives including selective withdrawal from Lake Oroville, Thermalito Afterbay, the hatchery, and the low flow section to meet various downstream temperature requirements.
- E14—evaluate operational alternatives that balance and maintain acceptable water quality standards including those for MTBE under all operational plans and conditions.
- E15—evaluate operation alternatives that maintain or improve current water supply under all operation plans and conditions.

4.0 Study Area

The study area includes the Oroville Reservoir, Thermalito Forebay – Afterbay complex and the Feather River low flow channel from the diversion dam to just downstream of the Thermalito Afterbay return. Geographic scope may be refined as additional information is developed and needs are identified through collaboration with other Work Groups.



5.0 General Approach

This study will evaluate potential models and tools that could be used to develop a local operations model of the Oroville – Thermalito Complex. The resulting model will attempt to maximize the power generation within the storage, release, and flow requirements on the system.

Power production is different from water operations because of the way electrical power is required. Since electrical power cannot be easily stored in large quantities generation must match demand at all times. The demand for electricity is higher during some portions of the day, the "on-peak" period and lower in others, the "off-peak" period. Electricity generated during the on-peak portion of the day is worth more money than that generated during the peak portion of the day. The Oroville/Thermalito complex is very valuable for electrical generation because of its ability to quickly turn on and off generation to meet peak loads and because it can use less valuable off-peak power to pump water back through the generators to generate more valuable on-peak power as it is needed, (in effect this is storing electrical power with an economic cost).

Because of the difference in value of electrical generation at different times of the day power generation is typically simulated on an hourly timestep. The actual power generation is driven by the economics of operation to meet a given electric demand curve with a given mix of generation and/or power contract options to supply the power to meet the demands. The Oroville/Thermalito complex is operated in conjunction with other SWP power facilities as well as contractual obligations and resources. Further complicating the analysis is the fact that since electrical power generation is driven by both the need to meet the current hours load and the need to reserve capacity to meet loads in future hours. For example, you do not want to use all available water for generation in off peak hours and miss the opportunity to use that water for generation during on-peak hours later in the week. Power generation models optimize the power generation over a longer time interval, typically a week, to maximize overall economic value of the power generated.

Detailed Methodology and Analysis Procedures

Task 1 - Define Desired Outputs from the Model

As currently formulated the required products from this model include:

- Oroville Reservoir Release
- Diversion Pool release to Thermalito Forebay
- Diversion Pool release to low flow section of Feather River
- Pump/Generation at Hyatt Powerhouse
- Release from Thermalito Forebay to Thermalito Afterbay
- Pump/Generation at Thermalito Powerhouse
- Diversion from Thermalito Afterbay
- Release from Thermalito Afterbay to the Feather River
- Feather River flow below Thermalito Afterbay return

The products are required on an hourly timestep basis to allow for pumpback operations to be accurately defined. The values will be used directly in other analysis as well as input to other models as boundary or baseline conditions.
Additional desired outputs may be identified as the study plans from other work groups are completed and the process proceeds.

Task 2—Review Existing Models

There are two existing models that DWR has proposed modifying for use as the local operations model, these are:

- DWR's COLOSSUS model – This is an hourly model developed by DWR to simulate water and power operations of the entire SWP system, not just the Oroville – Thermalito Complex. The model was developed for operational, not planning purposes.
- DWR's CALSIM II model - This is a monthly time step model developed by DWR to simulate statewide SWP/CVP water operations and is missing some critical physical features of the Oroville – Thermalito Complex. The model was developed for long term planning purposes.

Task 3—Review Existing Data

Types of data required include:

- Physical system description
- Inflows
- Flows
- Releases
- Diversions
- Oroville/Thermalito water levels
- Power generation including pumpback

Existing data identified at this time is listed in Attachments B and C.

Task 4—Review Modeling Tools

There are a number of modeling tools that may be appropriate for use to build the Local Operation Simulation model. The existing modeling tools include the following:

- PROSYM-WATERWAY (Henwood Energy Systems Inc) **-** PROSYM is power system dispatch tool, WATERWAY is flow operation modeling tool. These tools can be linked to create hydropower system simulation tool.
- VISTA (Acres International) – This is a specialized hydropower system simulation development tool including both water and power operation capability.
- HYDROPS (Charles Howard & Associates, Ltd) – This is a specialized hydropower system simulation development tool including both water and power operation capability.

Each of these tools, and possibly others, will be evaluated for suitability to meet the needs identified in Task 1.

Task 5—Select Appropriate Model or Modeling Tool

Based on the results of task 1 through 4 select the appropriate model/modeling tool to create the Local Operations Model for this process. The workgroup will approve the model/modeling tool selection.

Task 6—Collect Field Data for development/Calibration/Verification

Each model or modeling tool requires specific data for development/calibration/verification purposes. Once the model or modeling tool has been selected the specific data required to perform these tasks can be identified and compared to all known existing data to see if additional data is required to complete the model development.

Subtasks for this include:

- Identify additional data required;
- Install instrumentation as required; and,
- Collect data.

Task 7—Model Development/Calibration/Verification

The local operations model will encompass all major facilities in the Oroville – Thermalito complex. These include:

- Oroville Reservoir;
- Hyatt Powerhouse (Pump/Generator);
- Thermalito Forebay;
- Thermalito Powerhouse (Pump/Generator);
- Thermalito Afterbay;
- Diversion Dam and Pool; and
- Low Flow Feather River Channel.

A proposed schematic of the local operation model is included as Attachment A.

Typical model development subtasks include:

- Select model/modeling tool for use
- Develop physical system definition in model
- Develop time-series input data (hydrologic, operational)
- Identify additional required data including type of data, quality of data and locations for collection. Specify monitoring needs including instrumentation and data collection processes required to obtain the data.
- Begin model development with existing data. Use assumed values for additional required data until it is collected.
- Perform model modifications, if required, for pumpback operations
- Calibrate/verify the model
- Develop "seasonal" operation tools or model modifications if required

The calibration/verification process will likely be the longest process involved in the study plan.

Task 8—Integrate Completed Model into Model Development Scheme

Integration of the model into the model development scheme will require development of the transfer utilities defined in Study #E1. These transfer utilities will be used for three main purposes:

- Extract data from the central modeling database; modify this data as required for input to the Local Operations Model.
- Extract data from the Local Operations Model output files, perform any computation on them that may be required and store the results in the central modeling database.
- Allow review of all data being transferred for quality control purposes.

Task 9—Perform Benchmark Simulations

Perform the local operations modeling to provide the detailed benchmark simulations by performing the following actions:

- Get boundary conditions from central modeling database
- Use utility programs to create input based on the boundary conditions
- Perform the actual simulations
- Use utility programs to load data into central modeling database

The development will also be coordinated with study plans from other workgroups that will require evaluation of temperature impacts on Oroville releases.

6.0 Results and Products/Deliverables

Results

This study plan will result in a local operations simulation model and benchmark studies for use in the process.

Products/Deliverables

There will be two products of this study plan:

- A local operation model of the Oroville – Thermalito Complex that includes both water operations as well as power operations. This product will be fully integrated into the overall modeling scheme.
- Simulated local operations for the benchmark studies for use in other analysis.

7.0 Coordination and Implementation Strategy

Coordination with Other Resource Areas/Studies

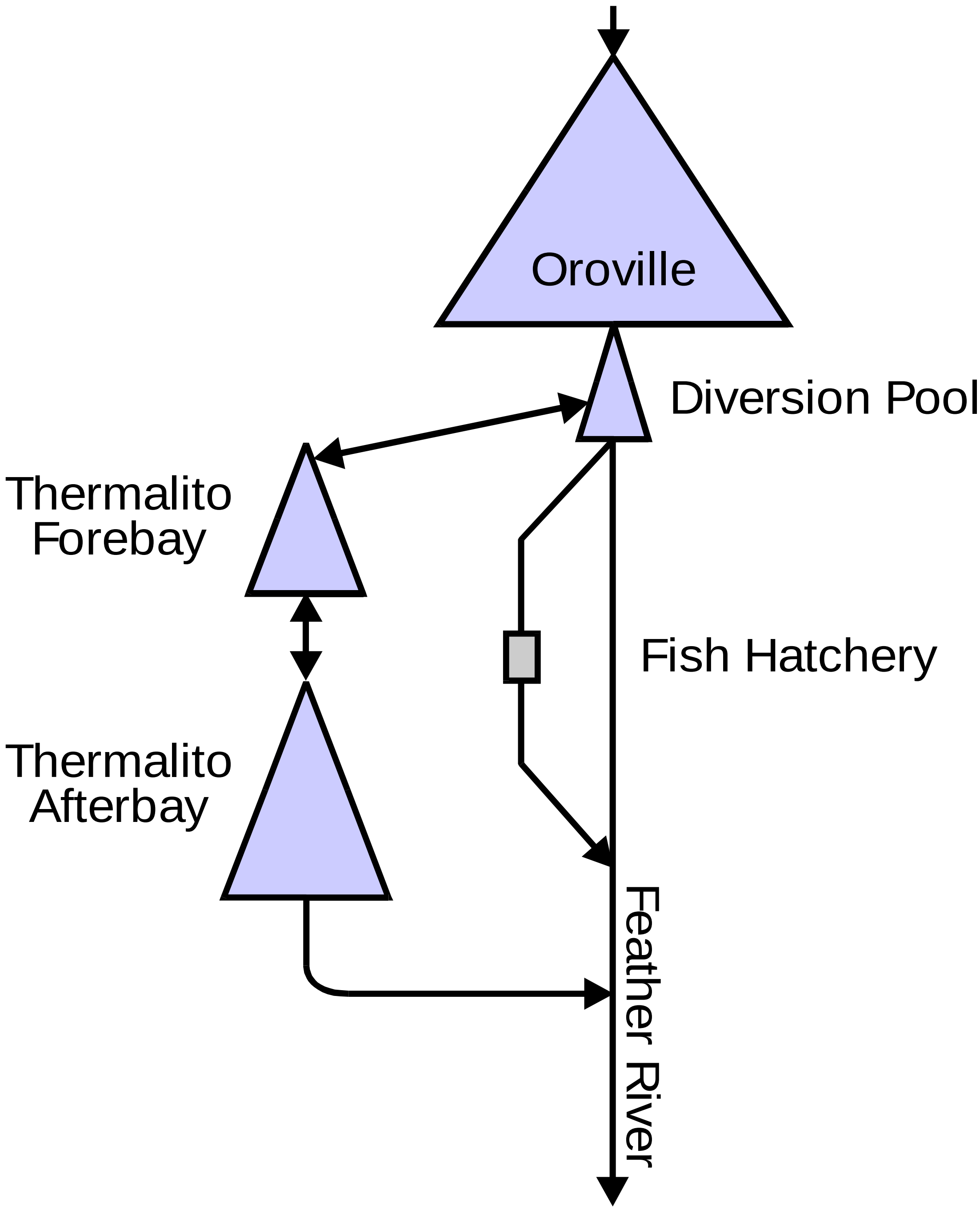
This section to be developed.

Engineering and Operations Study Plans

- Study Plan #1—Model Development
- Study Plan #1a—Statewide Operations Model Development
- Study Plan #1c—Oroville Reservoir Temperature Model Development
- Study Plan #1e—Feather River Temperature Model Development
- Study Plan #2—Modeling Simulation
- Study Plan #3—Hydropower Generation

The development will also be coordinated with study plans from other workgroups that will require detailed operations data.

Attachment A
Schematic of Local Operations Model



Attachment B
State Water Project Operations Data

	Location	Data Description	Data Description 2	Units	Data Type	Start Date	End Date	Data Source
1	Lake Oroville	Water Surface Elevation		Feet	Daily	Jan-90	Present	SWP
2	Lake Oroville	Storage		Acre-Feet	Daily	Jan-90	Present	SWP
3	Lake Oroville	Storage Change		Acre-Feet	Daily	Jan-90	Present	SWP
4	Lake Oroville	Outflow	Hyatt Powerplant	Acre-Feet	Daily	Jan-90	Present	SWP
5	Lake Oroville	Outflow	Palermo Canal	Acre-Feet	Daily	Jan-90	Present	SWP
6	Lake Oroville	Outflow	Evaporation	Acre-Feet	Daily	Jan-90	Present	SWP
7	Lake Oroville	Outflow	Spill	Acre-Feet	Daily	Jan-90	Present	SWP
8	Lake Oroville	Outflow	Total Outflow	Acre-Feet	Daily	Jan-90	Present	SWP
9	Lake Oroville	Inflow	Hyatt Powerplant Pumpback	Acre-Feet	Daily	Jan-90	Present	SWP
10	Lake Oroville	Inflow	Computed Inflow	Acre-Feet	Daily	Jan-90	Present	SWP
11	Thermalito Forebay	Storage		Acre-Feet	Daily	Jan-90	Present	SWP
12	Thermalito Forebay	Storage Change		Acre-Feet	Daily	Jan-90	Present	SWP
13	Thermalito Forebay	Inflow	Lake Oroville Releases	Acre-Feet	Daily	Jan-90	Present	SWP
14	Thermalito Forebay	Inflow	Kelly Ridge Generation	Acre-Feet	Daily	Jan-90	Present	SWP
15	Thermalito Forebay	Inflow	Thermalito Pumping-Generation Plant Pumpback	Acre-Feet	Daily	Jan-90	Present	SWP
16	Thermalito Forebay	Outflow	Thermalito Pumping-Generation Plant Pumpback	Acre-Feet	Daily	Jan-90	Present	SWP
17	Thermalito Forebay	Outflow	Butte County	Acre-Feet	Daily	Jan-90	Present	SWP
18	Thermalito Forebay	Outflow	Thermalito Irrigation District	Acre-Feet	Daily	Jan-90	Present	SWP
19	Thermalito Forebay	Outflow	Releases to River	Acre-Feet	Daily	Jan-90	Present	SWP
20	Thermalito Forebay	Outflow	Hyatt Powerplant Pumpback	Acre-Feet	Daily	Jan-90	Present	SWP
21	Thermalito Forebay	Losses and Gains		Acre-Feet	Daily	Jan-90	Present	SWP
22	Thermalito Afterbay	Water Surface Elevation		Feet	Daily	Jan-90	Present	SWP
23	Thermalito Afterbay	Storage		Acre-Feet	Daily	Jan-90	Present	SWP
24	Thermalito Afterbay	Storage Change		Acre-Feet	Daily	Jan-90	Present	SWP
25	Thermalito Afterbay	Inflow	Thermalito Pumping-Generation Plant Pumpback	Acre-Feet	Daily	Jan-90	Present	SWP
26	Thermalito Afterbay	Outflow	Sutter Butte Canal	Acre-Feet	Daily	Jan-90	Present	SWP
27	Thermalito Afterbay	Outflow	Western Canal Lateral	Acre-Feet	Daily	Jan-90	Present	SWP
28	Thermalito Afterbay	Outflow	Richvale Canal	Acre-Feet	Daily	Jan-90	Present	SWP
29	Thermalito Afterbay	Outflow	Western Canal	Acre-Feet	Daily	Jan-90	Present	SWP
30	Thermalito Afterbay	Outflow	Afterbay River Outlet	Acre-Feet	Daily	Jan-90	Present	SWP

	Location	Data Description	Data Description 2	Units	Data Type	Start Date	End Date	Data Source
31	Thermalito Afterbay	Outflow	Thermalito Pumping-Generation Plant Pumpback	Acre-Feet	Daily	Jan-90	Present	SWP
32	Thermalito Afterbay	Losses and Gains		Acre-Feet	Daily	Jan-90	Present	SWP
33	Thermalito Afterbay	Total Releases to River		Acre-Feet	Daily	Jan-90	Present	SWP
34	Oroville-Thermalito Complex	Mean Daily Water Temperature	Thermalito Afterbay Outlet	Fahrenheit	Daily	Jan-90	Present	SWP
35	Oroville-Thermalito Complex	Mean Daily Water Temperature	Fish Hatchery	Fahrenheit	Daily	Jan-90	Present	SWP
36	Oroville-Thermalito Complex	Lake Oroville Temperature Profile	Graph of Temp by Elevation	Fahrenheit/Feet	Daily	Jan-90	Present	SWP
37	Oroville and Delta Field Divisions Energy Data	Oroville-Thermalito Complex	Generation	KWH	Daily	Jan-90	Present	SWP
38	Oroville and Delta Field Divisions Energy Data	Oroville-Thermalito Complex	Load	KWH	Daily	Jan-90	Present	SWP
39	Oroville and Delta Field Divisions Energy Data	Baker Slough Pumping Plant Load		KWH	Daily	Jan-90	Present	SWP
40	Oroville and Delta Field Divisions Energy Data	Cordelia Pumping Plant Load		KWH	Daily	Jan-90	Present	SWP
41	Oroville and Delta Field Divisions Energy Data	Banks Pumping Plant	Total Load	KWH	Daily	Jan-90	Present	SWP
42	Oroville and Delta Field Divisions Energy Data		SWP Load	KWH	Daily	Jan-90	Present	SWP
43	Oroville and Delta Field Divisions Energy Data	South Bay Pumping Plant Load		KWH	Daily	Jan-90	Present	SWP
44	Oroville and Delta Field Divisions Energy Data	Del Valle Pumping Plant Load		KWH	Daily	Jan-90	Present	SWP

Attachment C
California Data Exchange Center

Ensor	Data Description	Data Type	Start Date	End Date	Station	Hydrologic Area
1	RIVER STAGE (feet)	(event)	9/10/1997	present	FEATHER RIVER AT BOYD'S LANDING (FBL)	
1	RIVER STAGE (feet)	(event)	9/10/1997	present	FEATHER RIVER AT LIVE OAK (FLO)	
1	RIVER STAGE (feet)	(event)	2/23/1995	present	FEATHER RIVER AT YUBA CITY (YUB)	
1	RIVER STAGE (feet)	(event)	1/5/1999	present	FEATHER RIVER NEAR GRIDLEY (GRL)	
1	RIVER STAGE (feet)	(event)	2/23/1995	present	FEATHER RIVER NEAR NICOLAUS (NIC)	
1	RIVER STAGE (feet)	(event)	2/10/1998	present	NORTH FORK FEATHER RIVER AT PULGA (PLG)	
1	RIVER STAGE (feet)	(hourly)	10/7/1997	present	FEATHER RIVER AT LIVE OAK (FLO)	
1	RIVER STAGE (feet)	(hourly)	1/5/1984	present	FEATHER RIVER AT MERRIMAC (MER)	
1	RIVER STAGE (feet)	(hourly)	1/1/1984	present	FEATHER RIVER AT YUBA CITY (YUB)	
1	RIVER STAGE (feet)	(hourly)	1/1/1984	present	FEATHER RIVER NEAR GRIDLEY (GRL)	
1	RIVER STAGE (feet)	(hourly)	1/1/1984	present	FEATHER RIVER NEAR NICOLAUS (NIC)	
1	RIVER STAGE (feet)	(hourly)	3/18/1998	present	NORTH FORK FEATHER RIVER AT PULGA (PLG)	
2	PRECIPITATION, ACCUMULATED (inches)	(hourly)	1/1/1984	present	OROVILLE DAM (ORO)	SACRAMENTO RIVER
2	PRECIPITATION, ACCUMULATED (inches)	(monthly)	10/1/1962	present	FEATHER RIVER NEAR NICOLAUS (NIC)	
2	PRECIPITATION, ACCUMULATED (inches)	(monthly)	10/1/1989	5/1/1994	OROVILLE FISH HATCH. (ORF)	
2	PRECIPITATION, ACCUMULATED (inches)	(monthly)	10/1/1939	9/1/1991	OROVILLE RS (ORS)	
3	SNOW, WATER CONTENT (inches)	(monthly)	4/1/1930	present	FEATHER RIVER MEADOW (FEM)	
6	RESERVOIR ELEVATION (feet)	(daily)	2/14/1985	present	OROVILLE DAM (ORO)	SACRAMENTO RIVER
6	RESERVOIR ELEVATION (feet)	(hourly)	1/1/1984	present	OROVILLE DAM (ORO)	SACRAMENTO RIVER
7	RESERVOIR, SCHEDULED RELEASE (cfs)	(event)	10/1/1995	present	OROVILLE DAM (ORO)	SACRAMENTO RIVER
8	FULL NATURAL FLOW (cfs)	(daily)	4/21/1985	present	OROVILLE DAM (ORO)	SACRAMENTO RIVER
14	BATTERY VOLTAGE (volts)	(event)	7/31/2000	present	FEATHER RIVER AT MILE 61.6 (FRA)	
14	BATTERY VOLTAGE (volts)	(event)	2/23/1995	present	FEATHER RIVER AT YUBA CITY (YUB)	
14	BATTERY VOLTAGE (volts)	(event)	1/5/1999	present	FEATHER RIVER NEAR GRIDLEY (GRL)	
14	BATTERY VOLTAGE (volts)	(event)	2/23/1995	present	FEATHER RIVER NEAR NICOLAUS (NIC)	
14	BATTERY VOLTAGE (volts)	(hourly)	10/7/1997	present	FEATHER RIVER AT LIVE OAK (FLO)	
14	BATTERY VOLTAGE (volts)	(hourly)	1/1/1995	present	FEATHER RIVER AT MERRIMAC (MER)	
14	BATTERY VOLTAGE (volts)	(hourly)	1/1/1995	present	FEATHER RIVER AT YUBA CITY (YUB)	
14	BATTERY VOLTAGE (volts)	(hourly)	1/1/1995	present	FEATHER RIVER NEAR GRIDLEY (GRL)	
14	BATTERY VOLTAGE (volts)	(hourly)	1/1/1995	present	FEATHER RIVER NEAR NICOLAUS (NIC)	
14	BATTERY VOLTAGE (volts)	(hourly)	2/19/1998	present	NORTH FORK FEATHER RIVER AT PULGA (PLG)	
14	BATTERY VOLTAGE (volts)	(hourly)	1/1/1995	present	OROVILLE DAM (ORO)	SACRAMENTO RIVER

Ensor	Data Description	Data Type	Start Date	End Date	Station	Hydrologic Area
15	RESERVOIR STORAGE (af)	(daily)	2/13/1985	present	OROVILLE DAM (ORO)	SACRAMENTO RIVER
15	RESERVOIR STORAGE (af)	(daily)	1/1/1985	present	THERMALITO AFTERBAY (TAB)	
15	RESERVOIR STORAGE (af)	(hourly)	1/1/1984	present	OROVILLE DAM (ORO)	SACRAMENTO RIVER
15	RESERVOIR STORAGE (af)	(monthly)	10/1/1967	present	OROVILLE DAM (ORO)	SACRAMENTO RIVER
15	RESERVOIR STORAGE (af)	(monthly)	10/1/1967	present	THERMALITO AFTERBAY (TAB)	
15	RESERVOIR STORAGE (af)	(monthly)	10/1/1969	present	THERMALITO DIVERS POOL (THD)	
15	RESERVOIR STORAGE (af)	(monthly)	10/1/1969	present	THERMALITO FOREBAY (TFR)	
15	RESERVOIR STORAGE (af)	(monthly)	10/1/1969	present	THERMALITO TOTAL (TMT)	
20	FLOW, RIVER DISCHARGE (cfs)	(event)	1/5/1999	present	FEATHER RIVER NEAR GRIDLEY (GRL)	
20	FLOW, RIVER DISCHARGE (cfs)	(event)	2/10/1998	present	NORTH FORK FEATHER RIVER AT PULGA (PLG)	
20	FLOW, RIVER DISCHARGE (cfs)	(hourly)	1/5/1984	present	FEATHER RIVER AT MERRIMAC (MER)	
20	FLOW, RIVER DISCHARGE (cfs)	(hourly)	1/1/1984	present	FEATHER RIVER NEAR GRIDLEY (GRL)	
20	FLOW, RIVER DISCHARGE (cfs)	(hourly)	3/18/1998	present	NORTH FORK FEATHER RIVER AT PULGA (PLG)	
22	RESERVOIR, STORAGE CHANGE (af)	(daily)	10/1/1993	present	OROVILLE DAM (ORO)	SACRAMENTO RIVER
23	RESERVOIR OUTFLOW (cfs)	(daily)	1/5/1987	present	OROVILLE DAM (ORO)	SACRAMENTO RIVER
23	RESERVOIR OUTFLOW (cfs)	(hourly)	2/6/1998	present	OROVILLE DAM (ORO)	SACRAMENTO RIVER
25	TEMPERATURE, WATER (deg f)	(event)	7/31/2000	present	FEATHER RIVER AT MILE 61.6 (FRA)	
41	FLOW, MEAN DAILY (cfs)	(daily)	1/1/1993	present	FEATHER RIVER AT MERRIMAC (MER)	
41	FLOW, MEAN DAILY (cfs)	(daily)	1/1/1993	present	FEATHER RIVER NEAR GRIDLEY (GRL)	
45	PRECIPITATION, INCREMENTAL (inches)	(daily)	1/1/1987	present	OROVILLE DAM (ORO)	SACRAMENTO RIVER
65	FLOW, FULL NATURAL (af)	(monthly)	10/1/1925	8/1/1992	FEATHER MF NR CLIO (FTC)	
65	FLOW, FULL NATURAL (af)	(monthly)	10/1/1907	9/1/1970	FEATHER MF NR MERRIMAC (FTM)	
65	FLOW, FULL NATURAL (af)	(monthly)	10/1/1911	9/1/1995	FEATHER NF AT PULGA (FPL)	
65	FLOW, FULL NATURAL (af)	(monthly)	2/1/1905	9/1/1992	FEATHER NF NEAR PRATTVILLE (FPR)	
65	FLOW, FULL NATURAL (af)	(monthly)	10/1/1905	present	FEATHER R (OROVILLE) (FTO)	SACRAMENTO RIVER
65	FLOW, FULL NATURAL (af)	(monthly)	10/1/1900	9/1/1992	FEATHER SF AT PONDEROSA (FTP)	
66	FLOW, MONTHLY VOLUME (af)	(monthly)	10/1/1925	10/1/1925	FEATHER MF NR CLIO (FTC)	
66	FLOW, MONTHLY VOLUME (af)	(monthly)	10/1/1907	10/1/1907	FEATHER MF NR MERRIMAC (FTM)	
66	FLOW, MONTHLY VOLUME (af)	(monthly)	10/1/1911	10/1/1911	FEATHER NF AT PULGA (FPL)	
66	FLOW, MONTHLY VOLUME (af)	(monthly)	1/1/1905	present	FEATHER R (OROVILLE) (FTO)	SACRAMENTO RIVER
66	FLOW, MONTHLY VOLUME (af)	(monthly)	10/1/1900	10/1/1900	FEATHER SF AT PONDEROSA (FTP)	
68	EVAPORATION, LAKE COMPUTED (af)	(monthly)	10/1/1985	present	OROVILL-THERMALITO (ORT)	
69	FLOW, CANAL DIVERSION (AF) (af)	(monthly)	10/1/1985	present	FEATHER R (OROVILLE) (FTO)	SACRAMENTO RIVER
69	FLOW, CANAL DIVERSION (AF) (af)	(monthly)	3/1/1995	present	FEATHER RIVER(TRUCKE (FTT)	
69	FLOW, CANAL DIVERSION (AF) (af)	(monthly)	10/1/1985	present	THERMALITO FOREBAY (TFR)	
72	FLOW, IRRIG&CONSUMPTION (AF) (af)	(monthly)	10/1/1911	10/1/1911	FEATHER NF AT PULGA (FPL)	
74	EVAPORATION, LAKE COMPUTED (cfs)	(daily)	10/1/1994	present	OROVILLE DAM (ORO)	SACRAMENTO RIVER

Ensor	Data Description	Data Type	Start Date	End Date	Station	Hydrologic Area
76	RESERVOIR INFLOW (cfs)	(daily)	1/1/1994	present	OROVILLE DAM (ORO)	SACRAMENTO RIVER
76	RESERVOIR INFLOW (cfs)	(hourly)	1/23/1997	present	OROVILLE DAM (ORO)	SACRAMENTO RIVER
85	DISCHARGE,CONTROL REGULATING (cfs)	(daily)	9/21/1999	present	TOTAL RELEASE-FEATHER R BLW THERMALITO (THA)	
85	DISCHARGE,CONTROL REGULATING (cfs)	(hourly)	2/5/1998	present	OROVILLE DAM (ORO)	SACRAMENTO RIVER
85	DISCHARGE,CONTROL REGULATING (cfs)	(hourly)	2/5/1998	present	TOTAL RELEASE-FEATHER R BLW THERMALITO (THA)	
94	RESERVOIR, TOP CONSERV STORAGE (af)	(daily)	10/20/2000	present	OROVILLE DAM (ORO)	SACRAMENTO RIVER
110	FLOW, CANAL DIVERSION (CFS) (cfs)	(daily)	3/1/2001	present	FEATHER R (OROVILLE) (FTO)	SACRAMENTO RIVER